PATENT ABSTRACTS OF JAPAN

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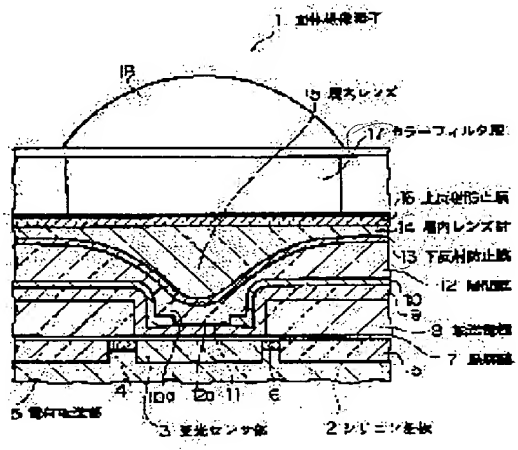
(54) SOLID-STATE IMAGE-PICKUP ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a solid state image-pickup element which can increase condensing efficiency and sensitivity by preventing reflection which occurrs between a within-layer lens and its upper or lower layer.
SOLUTION: This element includes a light-receiving sensor part 3 provided on a surface layer part of a substrate 2 for photoelectric conversion, a charge transfer part 5 for transferring a signal charge read out by the sensor part 3, and a transfer electrode 8 provided above the substrate 2 and nearly directly above the charge transfer part 5 through an insulating film 7. Provided above the sensor part 3 is a within-layer lens 15 for condensing an incident light into the sensor part 3. A color filter layer 17 is provided above the within-layer lens 15 through an anti-upward-reflection film 16. The film 16 is made of a material which has a refractive index between that of the lens 15 and that of the color filter layer 17.



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* NOTICES *

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CLAIMS

[Claim(s)]

[Claim 1] The solid state image pickup device which is characterized by providing the following and which is characterized by the bird clapper from material. The photo-sensor section which is prepared in the surface section of base and makes photo electric translation. The charge transfer section which transmits the signal charge read from this photo-sensor section. Have the transfer electrode prepared in the abbreviation right above position of the aforementioned charge transfer section on the aforementioned base through the insulator layer, the lens in a layer which condenses an incident light in the photo-sensor section is prepared on the aforementioned photo-sensor section it comes to prepare a light-filter layer on this lens in a layer through an upper antireflection film, and an above top antireflection film is a refractive index between the refractive index of the aforementioned lens in a layer, and the refractive index of a light-filter layer.

[Claim 2] The solid state image pickup device which is characterized by providing the following and which is characterized by the bird clapper from material. The photo-sensor section which is prepared in the surface section of base and makes photo electric translation. The charge transfer section which transmits the signal charge read from this photo-sensor section. Have the transfer electrode prepared in the abbreviation right above position of the aforementioned charge transfer section on the aforementioned base through the insulator layer, it comes to prepare the lens in a layer which condenses an incident light in the photo-sensor section through a lower antireflection film on the layer mesenteriolum on the aforementioned photo-sensor section, and the bottom antireflection film of the above is a refractive index between the refractive index of the aforementioned lens in a layer, and the refractive index of the layer mesenteriolum.

Claim 3] The solid state image pickup device according to claim 1 characterized by the bird clapper from the material into which the layer mesenteriolum is prepared in the bottom of the aforementioned lens in a layer through a lower antireflection film, and the bottom antireflection film of the above has a refractive index between the refractive index of the aforementioned lens in a layer, and the refractive index of the layer mesenteriolum.

Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention raises the condensing efficiency to the photo-sensor section, and relates to the solid state image pickup device which aimed at improvement in a sensitivity property.
[0002]
[Description of the Prior Art] In recent years, in a solid state image pickup device, the miniaturization and densification of a pixel progress further, light-receiving area is reduced in connection with this, and property degradation of a sensitivity fall etc. is caused. As a cure of a sensitivity fall, an on-chip lens and the lens in a layer are prepared, for example, and raising the condensing efficiency in the photo-sensor section is proposed and carried out.
0003]
Problem(s) to be Solved by the Invention] However, there is un-arranging [which states below] in the solid state mage pickup device which produced the lens in a layer by high refractive-index material. Since the refractive index of the light-filter layer usually formed on the lens in this layer is about 1.6 when a refractive index produces the lens n a layer by about 2.0 P-SiN (silicon nitride by the plasma CVD method), a refractive-index difference will become arge between the lens in a layer, and a light-filter layer, therefore reflection will occur by the interface, and a sensitivity property will fall. In addition, the reflection resulting from such a refractive-index difference is the thing o he property drawn from a wave equation.
0004] Moreover, although the layer mesenteriolum by which reflow processing etc. is made is formed in the bottom of the lens in a layer, BPSG (boron phosphorus silicate glass) whose refractive index is usually about 1.45 is used rom reflow processing being made as this layer mesenteriolum. Therefore, like the case of the point, a refractive-ndex difference will become large between the lens in a layer, and the layer mesenteriolum, and when reflection ccurs by the interface, a sensitivity property will fall.
0005] The place which this invention was made in view of the aforementioned situation, and is made into the urpose is to offer the solid state image pickup device which prevented the reflection which takes place between the ens in a layer, its upper layer, or a lower layer, raised condensing efficiency by this, and aimed at improvement in ensitivity.
0006]
Means for Solving the Problem] In the solid state image pickup device according to claim 1 in this invention The hoto-sensor section which is prepared in the surface section of a base and makes photo electric translation, and the harge transfer section which transmits the signal charge read from this photo-sensor section, It has the transfer lectrode prepared in the abbreviation right above position of the aforementioned charge transfer section on the foremention base through the insulator layer. On the aforementioned photo-sensor section, the lens in a layer hich condenses an incident light in the photo-sensor section is prepared. The light-filter layer was prepared through ne upper antireflection film on this lens in a layer, and it made into the solution means of the aforementioned chnical problem to have formed the above top antireflection film with the material which has a refractive index etween the refractive index of the aforementioned lens in a layer, and the refractive index of a light-filter layer.
0007] Since the upper antireflection film was formed between the light-filter layer and the lens in a layer with the aterial which has a refractive index between the refractive index of this light-filter layer, and the refractive index of ne lens in a layer according to this solid state image pickup device Even when the refractive-index difference etween a light-filter layer and the lens in a layer is large When the light-filter layer and the lens in a layer have not ined directly, the interface between these does not exist. The interface of the light-filter layer and upper ntireflection film which are a refractive-index difference smaller than the refractive-index difference between this ght-filter layer and the lens in a layer, and the interface of an upper antireflection film and the lens in a layer are cists. Therefore, since the interface of a big refractive-index difference turns into an interface of a small refractive-dex difference by having prepared the upper antireflection film, when there is an interface of a big refractive index, e reflection which takes place here is lost.

[0008] The photo-sensor section which is prepared in the surface section of a base and makes photo electric translation in a solid state image pickup device according to claim 2, The charge transfer section which transmits the signal charge read from this photo-sensor section, It has the transfer electrode prepared in the abbreviation right above position of the aforementioned charge transfer section on the aforementioned base through the insulator layer. On ****** on the aforementioned photo-sensor section, the lens in a layer which condenses an incident light in the photo-sensor section through a lower antireflection film was prepared, and it made into the solution means of the aforementioned technical problem to have formed the bottom antireflection film of the above with the material which has a refractive index between the refractive index of the aforementioned lens in a layer, and the refractive index of ******.

[0009] Since the lower antireflection film was formed between the lens in a layer, and ****** with the material which has a refractive index between the refractive index of this lens in a layer, and the refractive index of ****** according to this solid state image pickup device When the refractive-index difference between the lens in a layer and ****** is large, and the lens in a layer and ****** have not joined directly, the interface between these does not exist. The interface of the lens in a layer and lower antireflection film smaller than the refractive-index difference between this lens in a layer and ****** which are a refractive-index difference, and the interface of a lower antireflection film and ****** are exists. Therefore, since the interface of a big refractive-index difference turns into an interface of a small refractive-index difference by having prepared the lower antireflection film, when there is an interface of a big refractive index, the reflection which takes place here is lost.

[0010]

[Embodiments of the Invention] Hereafter, the solid state image pickup device of this invention is explained in detail Drawing 1 is drawing showing the example of 1 operation gestalt of the solid state image pickup device of this invention, in drawing 1 , a sign 1 is a solid state image pickup device, and 2 is a silicon substrate (base). As shown in drawing 1 , the light-receiving section (illustration abbreviation) which makes photo electric translation in the surface section is formed in a silicon substrate 2, and the hole accumulation section (illustration abbreviation) is further formed on this light-receiving section. And the photo-sensor section 3 of HAD (Holl Accumulation Diode) structure is formed from these light-receiving section and the hole accumulation section.

[0011] The charge transfer section 5 is formed through the read-out gate 4, and another charge transfer section 5 is formed in one of this photo-sensor section 3 side through the channel stop 6 at the another side side. And the obtained signal charge in which photo electric translation was carried out by such composition in the photo-sensor section 3 is read to the charge transfer section 5 through the read-out gate 4, and is further transmitted in this charge transfer section 5. moreover, SiO2 formed in the surface section of a silicon substrate 2 of the oxidizing [thermally] method, CVD, etc. from -- the becoming insulator layer 7 is formed In addition, about this insulator layer 7, it is SiO2. Not the monolayer that consists of a film but SiO2 Film-SiN film - SiO2 It is good also as the so-called cascade screen of the ONO structure which consists of three layers of a film.

[0012] On the insulator layer 7, the transfer electrode 8 which consists of contest the 1st polysilicon is formed in the abbreviation right above position of the aforementioned charge transfer section 5, further, it is in the state where parts overlap, in the transfer electrode 8, and another transfer electrode (illustration abbreviation) which consists of contest the 2nd polysilicon is formed. On the front-face top of these transfers electrode 8, i.e., the upper surface, and the side this transfer electrode 8 is covered and the transfer electrode 8 and the layer insulation film 9 which covers the insulator layer 7 on the photo-sensor section 3 which faces among eight, and consists of SiO2 are formed further.

[0013] On this ****** 9, where the aforementioned transfer electrode 8 is covered, the shading film 10 is formed. This shading film 10 is the thing in which buckling-of-track section 10a which it comes to ****** even right above of the light-receiving sensor section 3] was formed, in order to stop a smear, it is in the state where most right bove portions of the photo-sensor section 3 were made to face outside, namely, forms the rectangular opening 11 in the state where it enclosed by the aforementioned buckling-of-track section 10a right above [of the photo-sensor section 3]. Moreover, since the reflow processing by heat treatment is made in advance of formation of the lens in after [this shading film 10 formation] layer so that it may mention later, this shading film 10 is formed from the refractory metal so that a bad influence may not be received in the case of this reflow processing, and consists of a tungsten (W) in this example.

[0014] On this shading film 10, ****** 12 which covers this shading film 10 and the layer insulation film 9 which attends opening 11, and consists of BPSG (refractive-index; 1.45) is formed. This ****** 12 functions as a reflow film, and forms crevice 12a by covering transfer electrode 8 grade on this transfer electrode 8 and the photo-sensor section 3 between eight. Adjustment processing of the crevice 12a is carried out by carrying out reflow processing of ***** 12 at the predetermined curvature for the lens formation in a layer.

[0015] On this ****** 12, the front face is worn and the lower antireflection film 13 is formed. This lower antireflection film 13 consists of oxidization silicon nitride (it is hereafter described as P-SiON) formed by the plasma CVD method, and a refractive index is preferably adjusted to about 1.7 1.5 to about 1.9, and it is formed so that it may mention later. Moreover, this lower antireflection film 13 was formed in uniform thickness, without [without

thickness was formed in the about 100nm thin film and spoils preferably about 50-300nm of configurations of crevic
1a of ****** 12 by this, therefore] spoiling the function of the lens in a layer mentioned later.
[0016] The lens material 14 in a layer is formed by the state where crevice 12a of the layer mesenteriolum 12 was embedded on the lower antireflection film 13, and the lens 15 in a layer is constituted by this between this lens material 14 in a layer, and the layer mesenteriolum 12. The lens material 14 in a layer consists of silicon nitride (it is hereafter described as P-SiN) by the bias high-density plasma CVD method in this example. The refractive index of this P-SiN is 2.0. And therefore, between this and the lower antireflection films 13, The interface of the lens material 14 in these layers, and the lower antireflection film 13 since a refractive-index difference is furthermore between the layer mesenteriolum 12, And an incident light is refracted in the photo-sensor section 3 side by the interface of the lower antireflection film 13 and the layer mesenteriolum 12, and the lens 15 in a layer demonstrates the function by this. In addition, flattening of the lens material 14 in a layer is carried out by the resist etchback method the front face is well-known, or the CMP method (the chemical machinery grinding method).
[0017] Moreover, since the refractive index is a refractive index between the refractive index (1.45) of 1.5 to about [12] 1.9, i.e., the layer mesenteriolum, and the refractive index (2.0) of the lens material 14 (lens 15 in a layer) in a layer, the bottom antireflection film 13 of the above Each of refractive-index differences in the interface between the lens material 14 (lens 15 in a layer) between layers and the lower antireflection film 13 and refractive-index differences in the interface of the lower antireflection film 13 and the layer mesenteriolum 12 becomes smaller than the refractive-index difference of the lens material 14 in a layer, and the layer mesenteriolum 12.
0018] The upper antireflection film 16 is formed on the lens material 14 in a layer by which flattening was carried ut. Besides, an antireflection film 16 consists of P-SiON like the bottom antireflection film 13 of the above, and a efractive index is preferably adjusted to about 1.8 1.7 to about 1.9, and it is formed so that it may mention later. Moreover, this upper antireflection film 16 functions also as a passivation film, and is set as thickness in which the hickness demonstrates the function as a passivation film enough therefore.
0019] Besides on the antireflection film 16, the light-filter layer 17 is formed. This light-filter layer 17 consists of a esin etc., and the refractive index has become about 1.6 thing. The refractive index of an upper antireflection film ike the case of the lower antireflection film 13 mentioned above 1.7 to about [therefore,] 1.9 Namely, since it has a efractive index between the refractive index (1.6) of the light-filter layer 17, and the refractive index (2.0) of the lens naterial 14 (lens 15 in a layer) in a layer Each of refractive-index differences in the interface between the light-filter ayer 17 and the upper antireflection film 16 and refractive-index differences in the interface of the upper ntireflection film 16 and the lens material 14 (lens 15 in a layer) in a layer becomes smaller than the refractive-index lifference of the light-filter layer 17 and the lens material 14 in a layer.
0020] Moreover, on the light-filter layer 17, the on-chip lens 18 which consists of a convex transparent resin etc. is ormed. This on-chip lens 18 is for having been formed of the material whose refractive index is 1.5 to about 1.6, eading an incident light to the opening 11 of the shading film 10 through the lens 15 in a layer, and carrying out ncidence on the photo-sensor section 3.
0021] In order to produce such a solid state image pickup device 1, after forming even the transfer electrode 8 by the ame technique as usual, covering this further and forming the layer insulation film 9, the shading film 10 is formed. n addition, about this shading film 10, it is also possible to form as the same layer as the wiring in the circumference ircuit of a solid state image pickup device 1. Subsequently, by depositing BPSG on the state where the shading film 0 grade was covered by CVD etc., and carrying out reflow processing (heat treatment) on the conditions set up rther beforehand as a material of the layer mesenteriolum 12, it forms so that it may become the configuration of ie lens 15 in a layer of asking for the curvature of the crevice 12a. In addition, in setting up the conditions of such eflow processing, the simulation etc. determines the configuration of the optimal lens 15 in a layer beforehand, and ie conditions for acquiring this optimal lens configuration in a layer by an experiment, the simulation, etc. further re searched for. About the optimal configuration of the lens 15 in a layer, it considers as the configuration suitably efracted according to the position and incident angle in an incident light with the on-chip lens 18 to lead the light hich carried out incidence to the lens 15 in a layer to the opening 11 of the shading film 10.
0022] Thus, if the layer mesenteriolum 12 is formed, by the plasma CVD method, the refractive index will deposit xidization silicon nitride (P-SiON) on the thickness of about 50-300nm on conditions which become about 1.7 eferably 1.5 to about 1.9, and the lower antireflection film 13 will be formed. Here, about adjustment of a refractive dex, it carries out by adjusting suitably the flow rate of SiH4 which is the material gas, NH3, and N2 O. Namely, iH4 It is NH3 when it considers as criteria. If flow rate is increased, a refractive index will become large, and a fractive index will become small if the flow rate of N2 O is increased. This is NH3 in a raw material. It is because e Si-O bond in P-SiON which will be obtained if the Si-N bond in P-SiON obtained will increase in number if it creases, and N2 O in a raw material increases on the other hand increases in number.
0023] Therefore, what is necessary is to ask for the relation between the flow rate of these material gas, and the fractive index of P-SiON obtained by the experiment or the simulation beforehand, and just to choose the condition itably according to the refractive index for which it asks in the case of formation of the lower antireflection film 13

Thus, if the lower antireflection film 13 is formed, the lens material 14 in a layer will be deposited and formed, flattening of the front face will be further changed into the state where crevice 12a of the layer mesenteriolum 12 was embedded, by the resist etchback method or the CMP method (the chemical machinery grinding method), and the lens 15 in a layer will be formed.

[0024] Subsequently, on this lens material 14 (lens 15 in a layer) in a layer that carried out flattening, by the plasma CVD method, the refractive index deposits oxidization silicon nitride (P-SiON) on conditions which become about 1.8 preferably 1.7 to about 1.9, and the upper antireflection film 16 is formed. In addition, about adjustment of a refractive index, it carries out by choosing the flow rate of material gas suitably like the case of the lower antireflection film 13 mentioned above.

[0025] Subsequently, by the staining technique or color resist application, the light-filter layer 17 is formed and the on-chip lens 18 is formed after that. After making the high density SiN in which CVD is possible deposit by the thermofusion nature transparent resin or no ordinary temperature heating and preparing a resist in the upper part further about formation of the on-chip lens 18 here, it is made the convex lens configuration which carries out heat reflow processing of this resist, and has desired curvature, this is further made into a mask, the aforementioned deposit is **********ed, and etchback imprint of removing a resist and obtaining the on-chip lens 18 etc. is used.

[0026] Thus, if it is in the obtained solid state image pickup device 1, it is condensed with the on-chip lens 18, and incidence is carried out to the lens 15 in a layer, the light condensed again (refraction) carries out incidence into the opening 11 of the shading film 10 through the lower antireflection film 13, the layer insulation film 9 and an insulato layer 7 are penetrated [the light-filter layer 17 and the upper antireflection film 16 are penetrated further,], it results in the photo-sensor section 3, and photo electric translation is made here.

[0027] At this time, by having formed the upper antireflection film 16, between the light-filter layer 17 and the lens 15 (lens material 14 in a layer) in a layer The interface of the light-filter layer 17 and the upper antireflection film 16, Since the interface of the upper antireflection film 16 and the lens 15 (lens material 14 in a layer) in a layer is exists and the interface of a big refractive-index difference turns into an interface of a small refractive-index difference, when there is an interface of a big refractive index, the reflection which takes place here is lost. Therefore, reflection between the light-filter layer 17 produced conventionally and the lens 15 (lens material 14 in a layer) in a layer can b reduced, condensing efficiency can be raised by this, and sensitivity can be improved.

0028] Moreover, since the interface of the lens 15 in a layer and the lower reflective film 13 and the interface of the ower reflective film 13 and the layer mesenteriolum 12 are exists by having formed the lower antireflection film 13 between the lens 15 (lens material 14 in a layer) in a layer, and the layer mesenteriolum 12 and the interface of a big efractive-index difference turns into an interface of a small refractive-index difference, when there is an interface of too big refractive index, the reflection which takes place here is lost. Therefore, reflection between the lenses 15 lens material 14 in a layer) in a layer and the layer mesenteriolum 12 which had been produced conventionally can e reduced, also by this, condensing efficiency can be raised and sensitivity can be improved.

0029] In addition, you may make it this invention form either the upper antireflection film 16 or the lower ntireflection film 13, although the upper antireflection film 16 was formed on the lens 15 in a layer and the lower ntireflection film 13 was formed in the bottom of the lens 15 in a layer in the aforementioned example of an peration gestalt, without being limited to this.

0030]

Effect of the Invention] As explained above, the solid state image pickup device according to claim 1 in this nvention Between a light-filter layer and the lens in a layer, an upper antireflection film is formed with the material hich has a refractive index between the refractive index of this light-filter layer, and the refractive index of the lens a layer. Do not join a light-filter layer and the lens in a layer directly, and it is made for the interface of these light- lters layer and the lens in a layer not to exist by this. The interface of the light-filter layer and upper antireflection lm which are a refractive-index difference small between these light-filters layer and the lens in a layer, Since it is ade for the interface of an upper antireflection film and the lens in a layer to exist, reflection between the light-filte yer produced conventionally and the lens in a layer can be reduced, condensing efficiency can be raised by this, and nsitivity can be improved.

0031] A solid state image pickup device according to claim 2 forms a lower antireflection film between the lens in a yer, and the layer mesenteriolum with the material which has a refractive index between the refractive index of this ns in a layer, and the refractive index of the layer mesenteriolum. Do not join the lens in a layer, and the layer esenteriolum directly, and it is made for the interface of the lens in these layers and the layer mesenteriolum not to ist by this. The interface of the lens in a layer and lower antireflection film small between the lens in these layers, d the layer mesenteriolum which are a refractive-index difference, Since it is made for the interface of a lower ntireflection film and the layer mesenteriolum to exist, reflection between the layer mesenteriolum produced nventionally and the lens in a layer can be reduced, condensing efficiency can be raised by this, and sensitivity can improved.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the important section sectional side elevation showing the outline composition of the example of 1 operation gestalt of the solid state image pickup device of this invention.
[Description of Notations]
1 [-- The photo-sensor section, 5 / -- The charge transfer section, 7 / -- An insulator layer, 8 / -- A transfer electrode, 12 / -- The layer mesenteriolum, 13 / -- A bottom antireflection film, 15 / -- The lens in a layer, 16 / -- A top antireflection film, 17 / -- Light-filter layer] -- A solid state image pickup device, 2 -- A silicon substrate (base), 3

Translation done.]